Development of Automated Dynamic Bidding Agents for Final Price Prediction in Online Auctions

A Thesis Submitted for the Degree of

Doctor of Philosophy

By

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UNIVERSITY OF TECHNOLOGY

SCHOOL OF SOFTWARE

The undersigned hereby certify that this thesis entitled "**Development of Automated Dynamic Bidding Agents for Final Price Prediction in Online Auctions**" by **Preetinder Kaur** has been read and is fully adequate, in scope and in quality, as a thesis for the degree of **Doctor of Philosophy**.

Research Supervisor: _____

Dr. Madhu Goyal

Dated: February 2014

CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Abstract

Online auctions have emerged as a well-recognised paradigm of item exchange over the past few years. In these environments, software agents are being used increasingly and promisingly to bid on or trade goods. This thesis presents an automated dynamic bidding agent framework that makes use of machine learning techniques to forecast bid amounts in simultaneous auctions of the same or similar items. The availability of numerous auctions of similar items complicates the situation of bidders who wish to choose the auction where their participation will give maximum surplus. These bidders also face a perpetual dilemma about how to predict an item's bargain price. Further, the diverse price dynamics of auctions for the same or similar items affect both the choice of auction and the valuation of the auctioned items. There is, thus, a critical need to characterise auctions based on their price dynamics before selecting one to compete in and assessing the true value of the auctioned items.

The main contributions of this thesis are its development of: (i) an automated dynamic bidding agent framework, (ii) an initial price estimation methodology for choosing an auction and assessing the value of auctioned goods, (iii) a final price prediction methodology that designs bidding strategies for buyers with different bidding behaviours and (iv) a simulated electronic marketplace for implementing and evaluating the performance of bidding agents.

The automated dynamic bidding agent (ADBA) framework selects an auction to participate in and predicts its final price in two phases: the first gives an initial estimation and the second phase delivers a final price prediction. The methodology for initial price estimation finds an auction to compete in and assesses the value of the auctioned item using data mining techniques. It handles the problem of diverse price dynamics in auctions for the same or similar items, using a clustering-based bid mapping and selection approach to locate the auction where participation would give maximum surplus. The value of the item is assessed with parametric and non-parametric machine learning approaches to predict the auction's closing price. The proposed approach is validated using real online auction datasets. These results

demonstrate that this clustering-based price prediction approach outperforms existing methodologies in terms of prediction accuracy.

This thesis also introduces a methodology for final price estimation which designs bidding strategies to address buyers' different bidding behaviours. This draws on two approaches: negotiation decision functions and fuzzy reasoning techniques. The bidding strategies are designed based on the bidder's own attitude to win the auction and the behaviour of rival bidders. A simulated electronic marketplace is implemented and developed using Java Agent DEvelopment Framework (JADE). The marketplace is also used to demonstrate the performance of the bidding strategies. The outcomes for heterogeneous and homogeneous bidders are measured separately in a wide variety of test environments subject to different auction settings and bidding restrictions. The results show that ADBA agents who follow this study's bidding strategies outperform other existing agents in most settings in terms of their success rate and expected utility.